



Mobility and Speciation of Radionuclides in Soil.

Anthony J. Bednar

Engineer Research and Development Center

US Army Corps of Engineers

Anthony.J.Bednar@erdc.usace.army.mil

Co-Authors:

Steven Larson, Victor Medina, Lee Johnson, Torrey Turner,
Jared Gilmore, and David Gent





Outline

- Two systems investigated thus far: Thorium and Uranium
- Field survey capabilities- rapid, *in situ* determination of distribution
- Mechanisms of mobilization in soil
 - Electrokinetic migration
 - Binding of radionuclides to NOM
- Investigations of organouranium complexes
 - MWC0 Filtration
 - RP-ICP-MS
 - SEC-UV-ICP-MS
 - Extraction from plant materials and microbial soil crusts
- Organic matter influence on sorption to soil





Field Characterization

ATV used to move NaI detectors across the site



Detectors under computer control measure activity in real time and correlate it with GPS coordinates

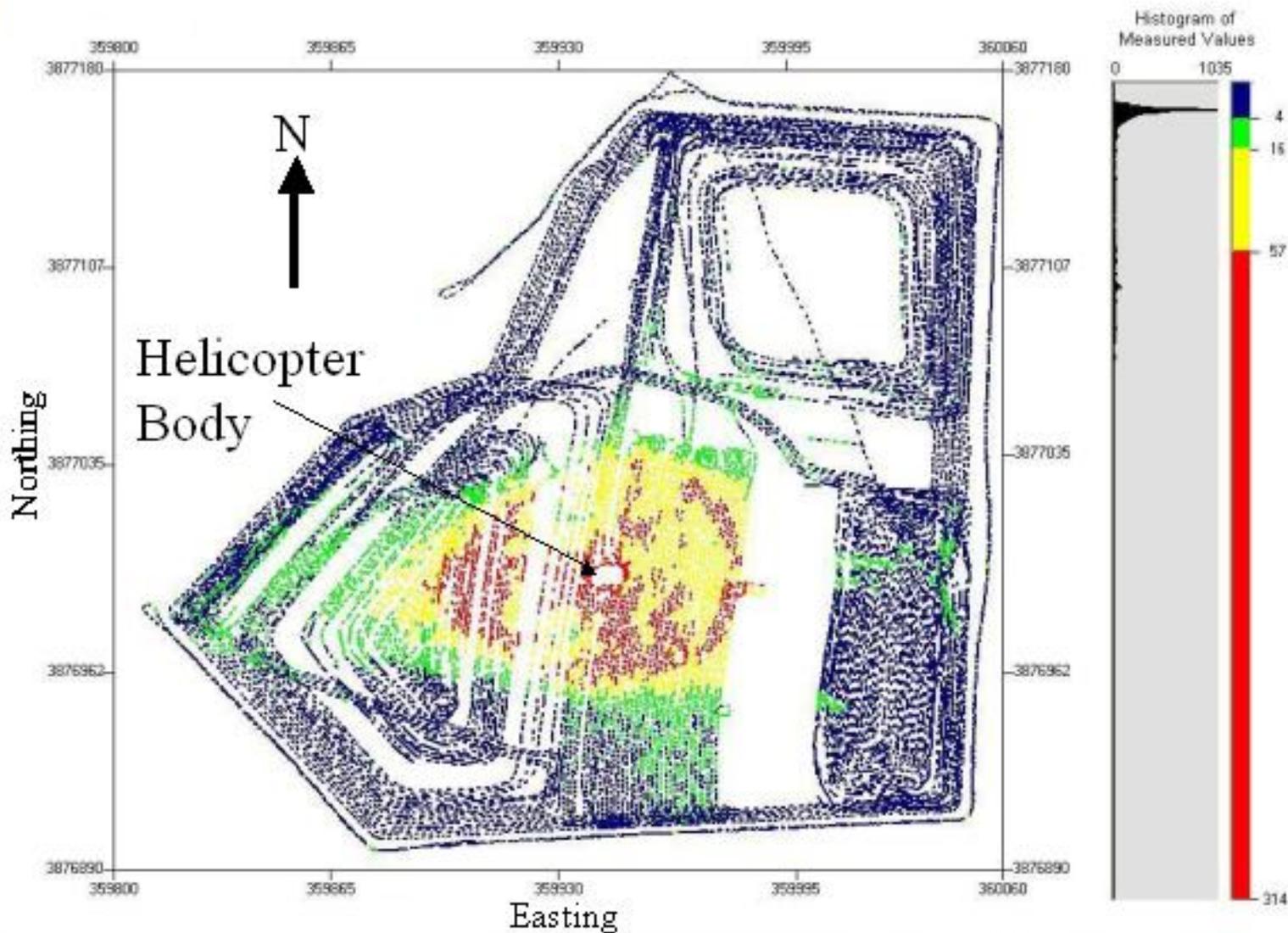


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Field Survey Results



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How do radionuclides move in soil?

- Solubilization and dissolved transport
 - Horizontal and vertical movement
 - Binding of radionuclides to humic materials
- Water-transported particulates
 - Colloids
- Wind-blown dust and detrital plant material



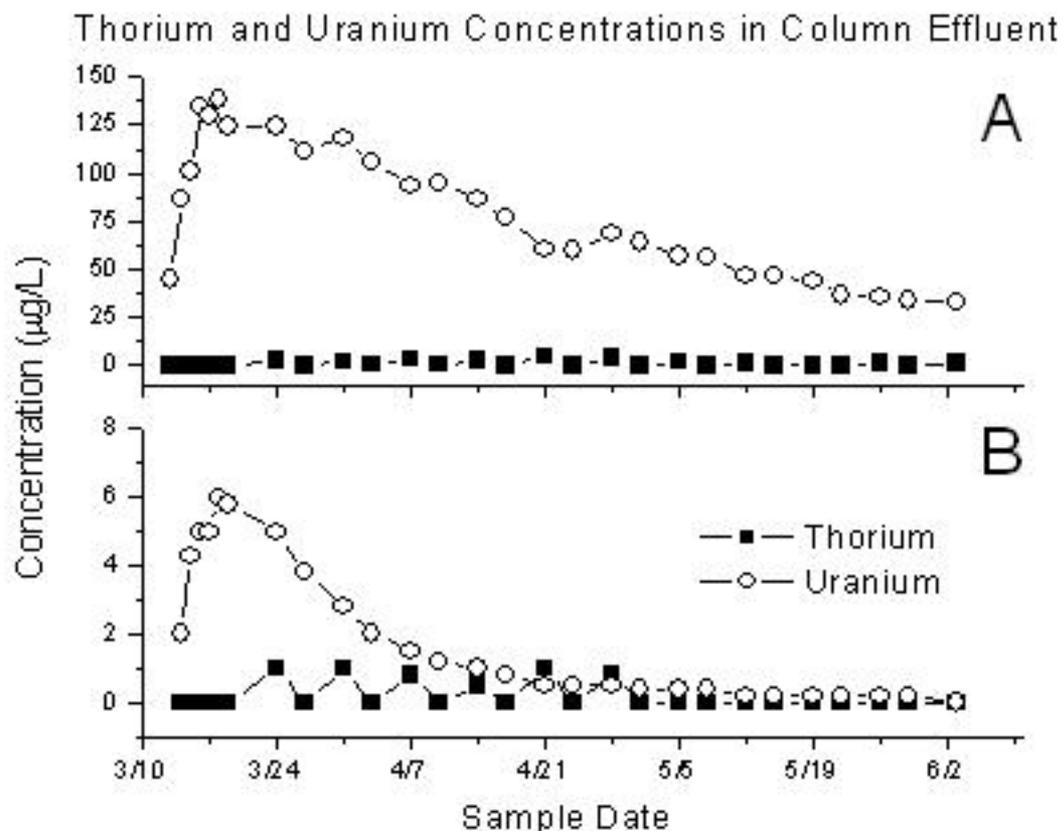
Solubilization and Vertical Migration

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B: Clean soil layer
below Thorium Soil

A: Thorium-containing soil



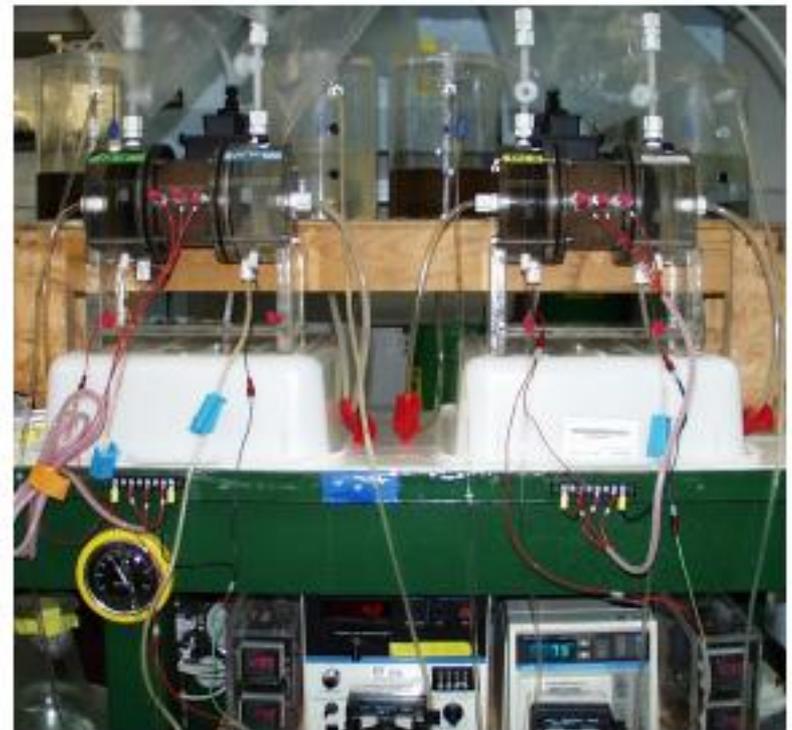
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Migration as a Charged Complex

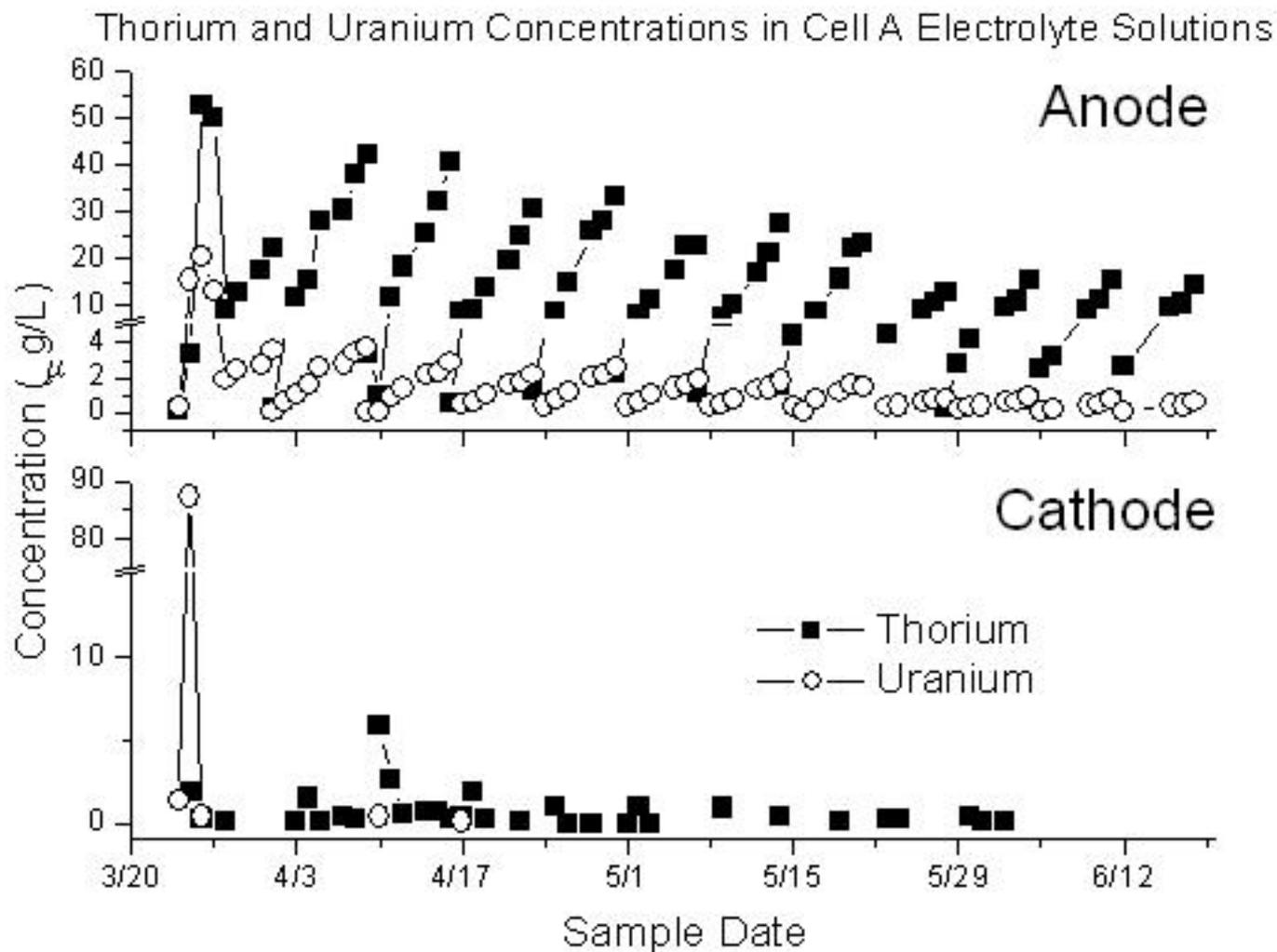
Electrokinetic mobility shows migration as a negative complex, most likely associated with NOM

Anode

Cathode



Cell A: Thorium-containing soil





Complex Chemistry of Radionuclide Complexes

- Previous example of Thorium and Uranium migrating as anionic complexes in EK experiments
 - Further characterize humic interactions
- Oxidation of DU and subsequent binding of corrosion products in soil





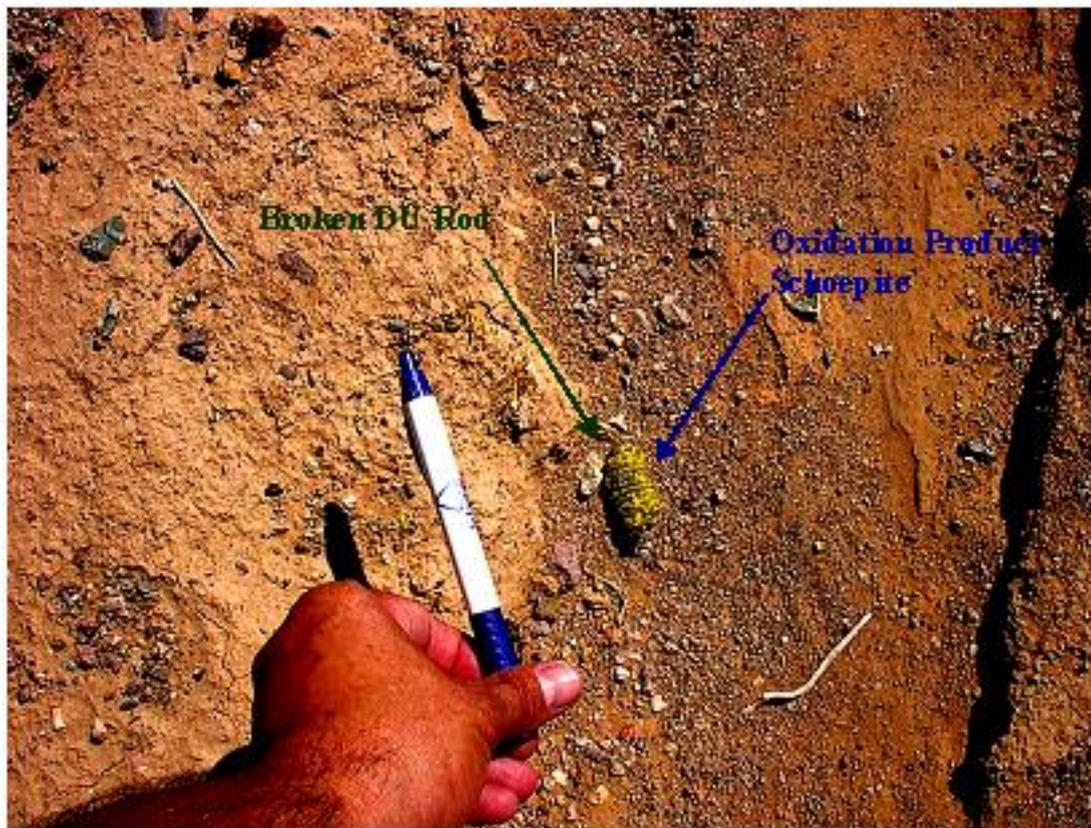
Oxidation and Mobility of DU

- Metallic DU is not mobile in the environment
- Corrosion produces oxidized U(VI)
 - Uranyl ion UO_2^{2+}
 - Investigate physical U form in soil with SEM
- Complexation with natural ligands can alter chemistry
 - Promote or hinder sorption
 - Increase mobility by solubilization



Oxidation of DU penetrator rods in desert environment

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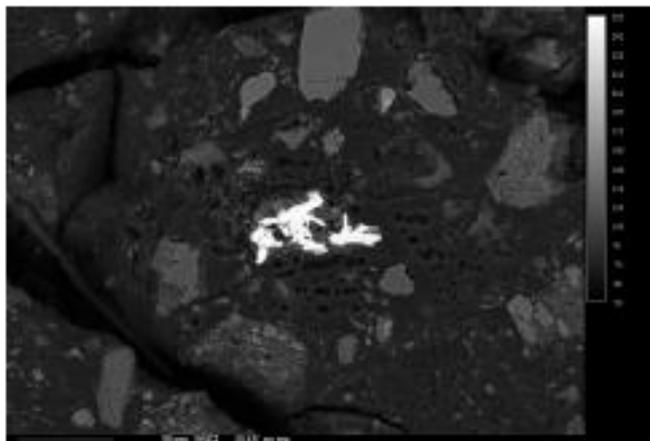
What is the form of DU in soil?

- Metallic particles?
- Oxidation products in crystalline form?
- Amorphous grain coatings?
- Probably all of the above.

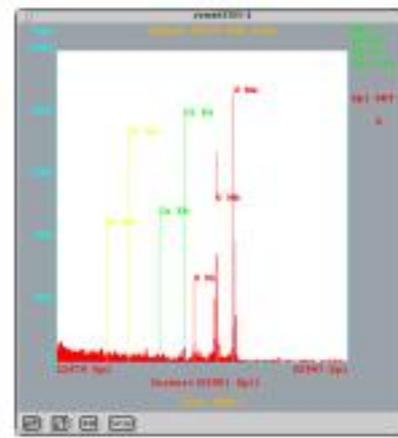
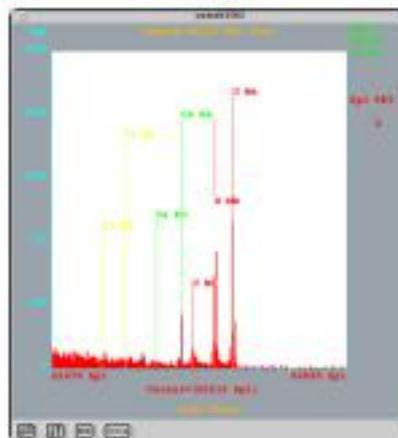


U particle Yuma-H350-3

BSE



Qualitative X-ray scans



U map





Investigation of dissolved U binding to natural organic matter (NOM)

Begin to determine the chemical form
of U in soil and plants





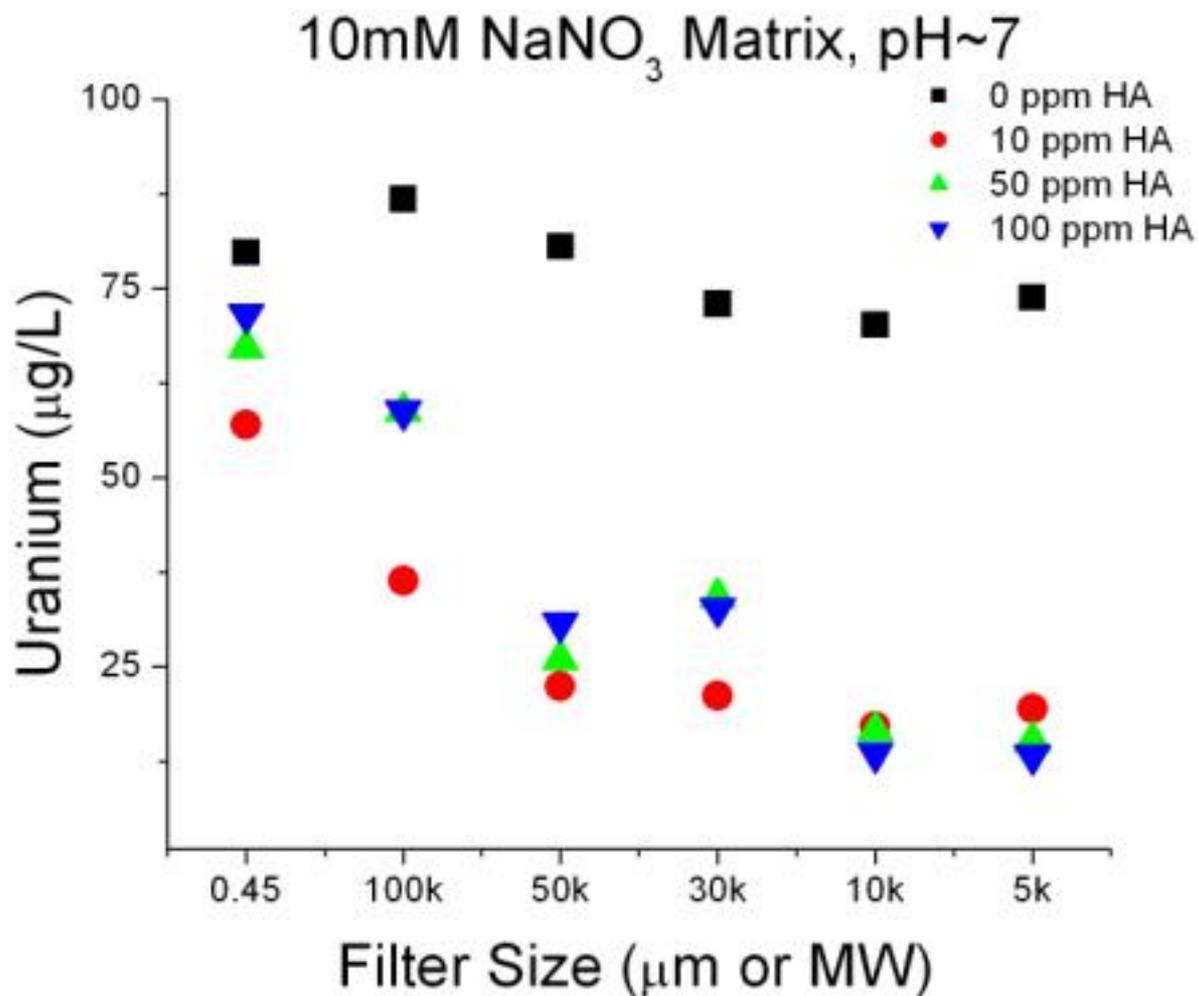
Humic Acid Solutions Used for Binding Studies



Molecular Weight Cut-Off Filter Devices



Binding of U by Natural Organic Matter (Humic Acid)



HPLC-ICP-MS

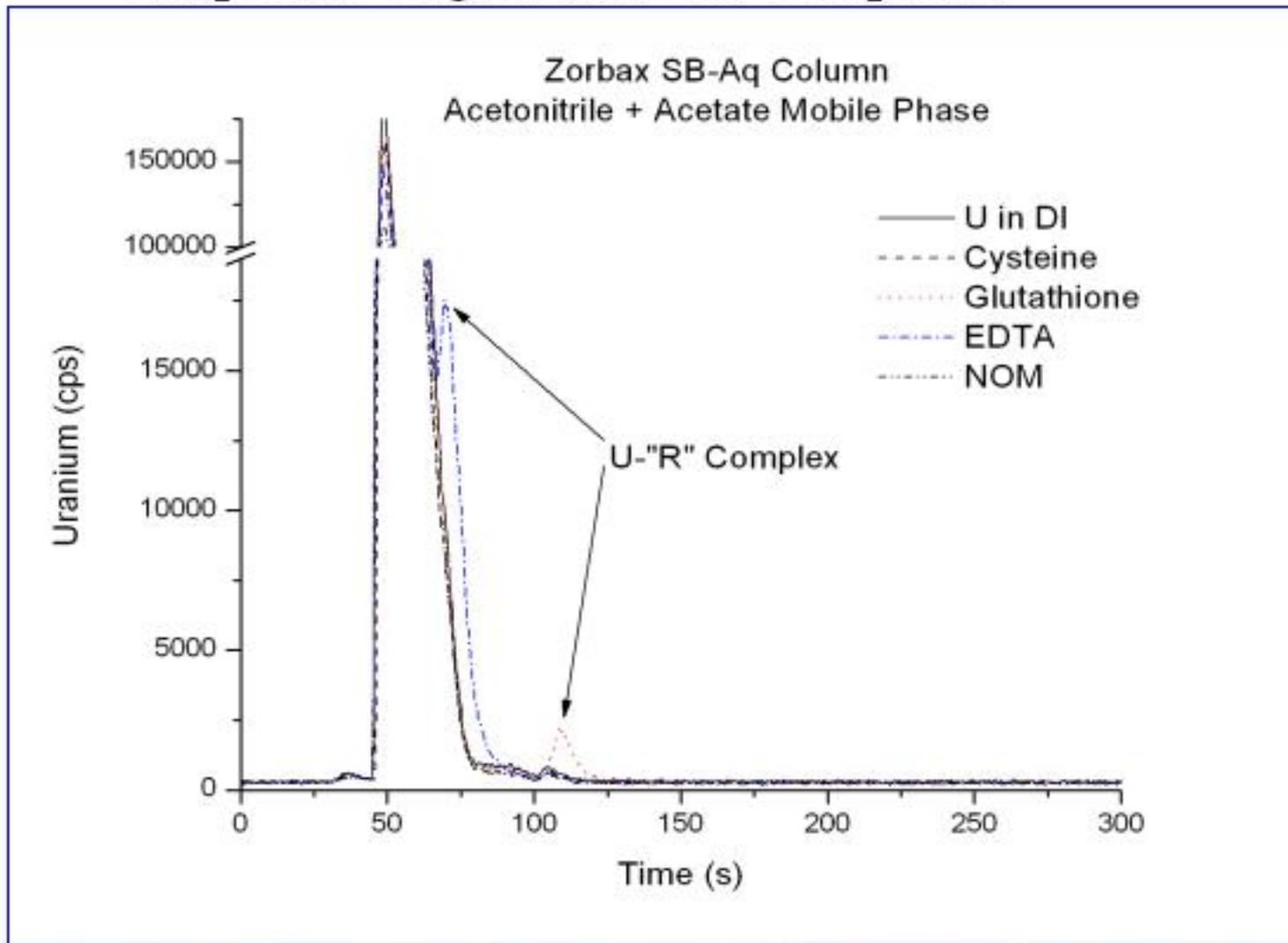


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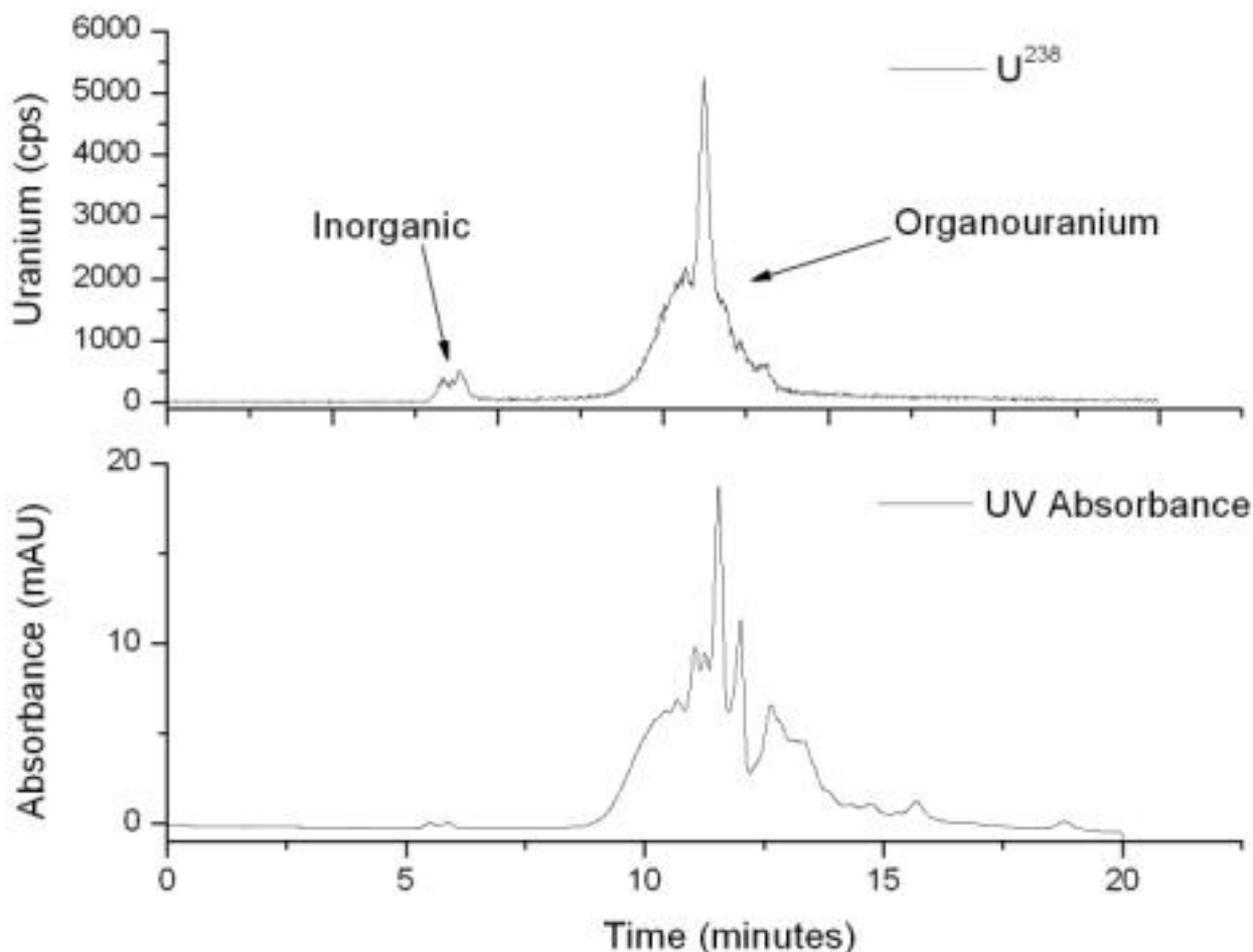


Reverse Phase HPLC-ICP-MS Chromatogram of Specific Organouranium Complexes



Size Exclusion HPLC-ICP-MS Chromatogram of Unidentified Organouranium Complexes from Plant Extracts

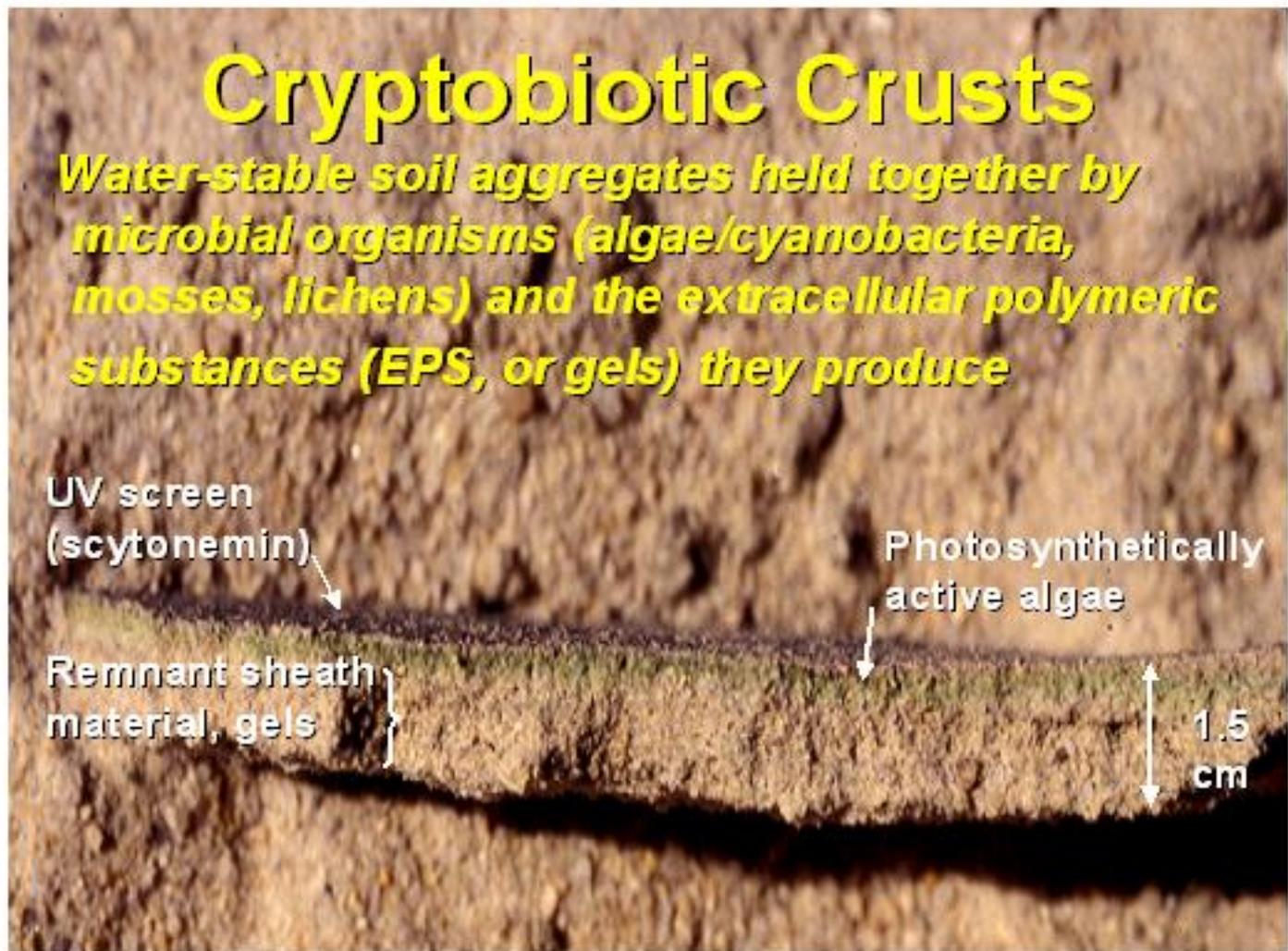
SEC-ICP-MS of 3PO51 Deionized Water Extract



Investigations of Microbial “Plants” and Uptake of Uranium

Cryptobiotic Crusts

Water-stable soil aggregates held together by microbial organisms (algae/cyanobacteria, mosses, lichens) and the extracellular polymeric substances (EPS, or gels) they produce



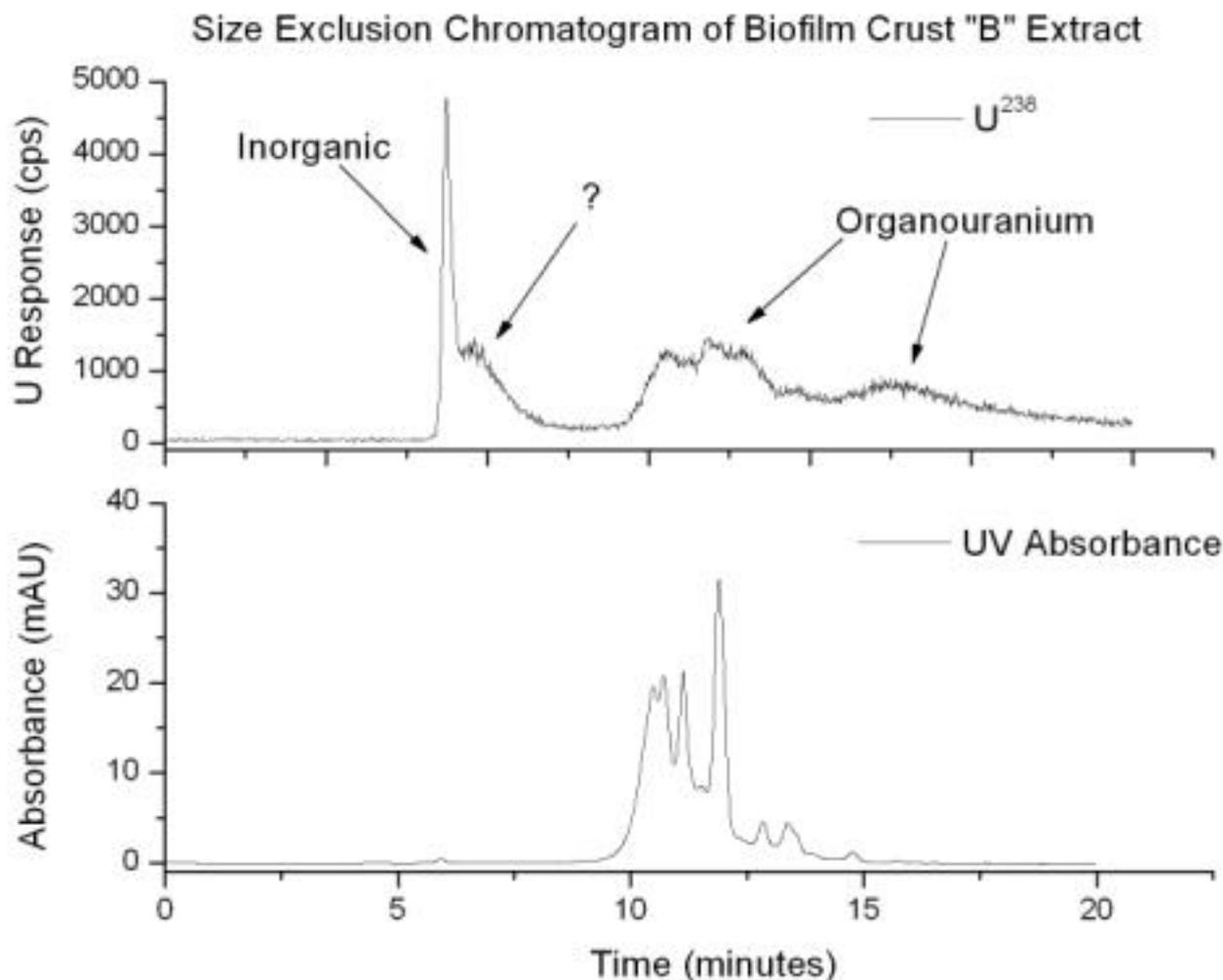
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Size Exclusion HPLC-ICP-MS Chromatogram of Unidentified Organouranium Complexes from Soil Crust Extracts

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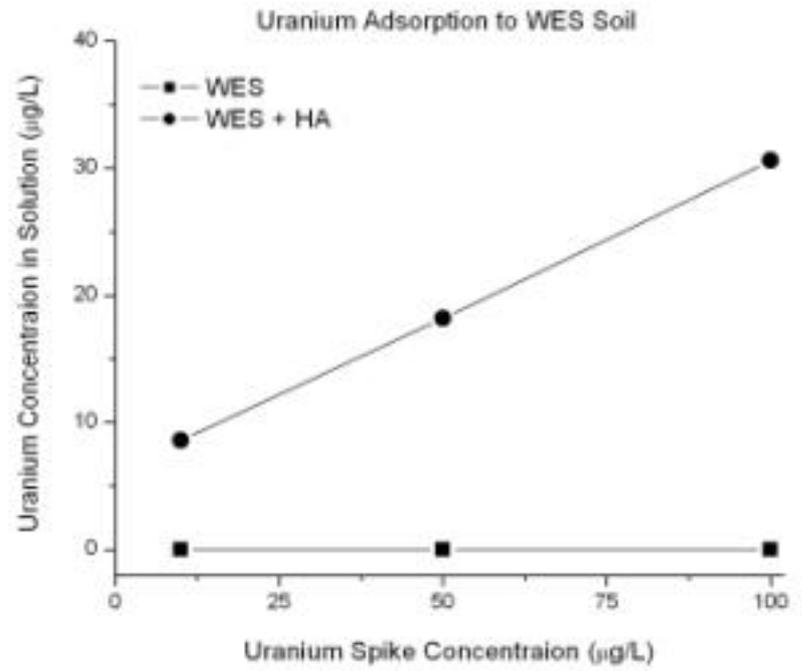
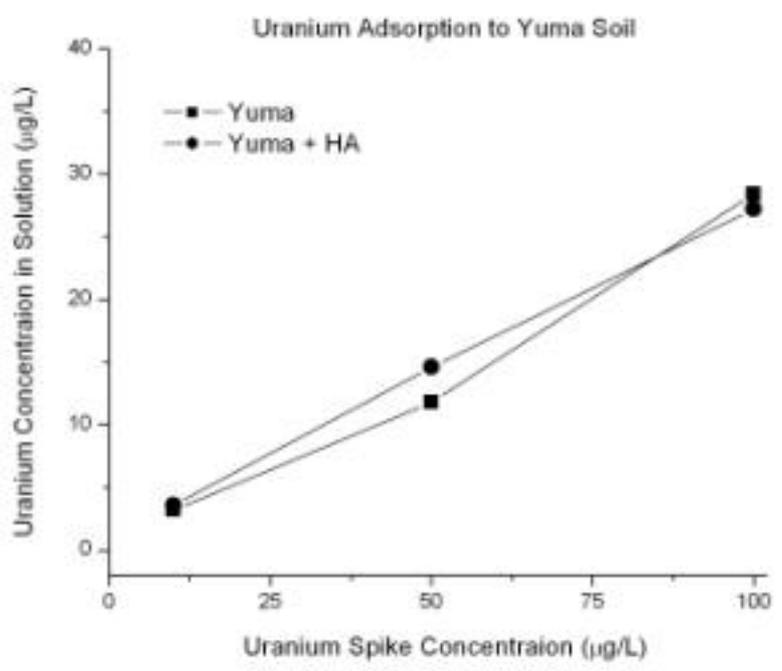
Organic Matter Influence on Uranium Sorption to Soil

- U binds to organic compounds, so...
- Do organic compounds affect sorption of U to soil
- Do organic compounds affect desorption of U from soil

Most likely a question of which came first, the chicken or the egg?

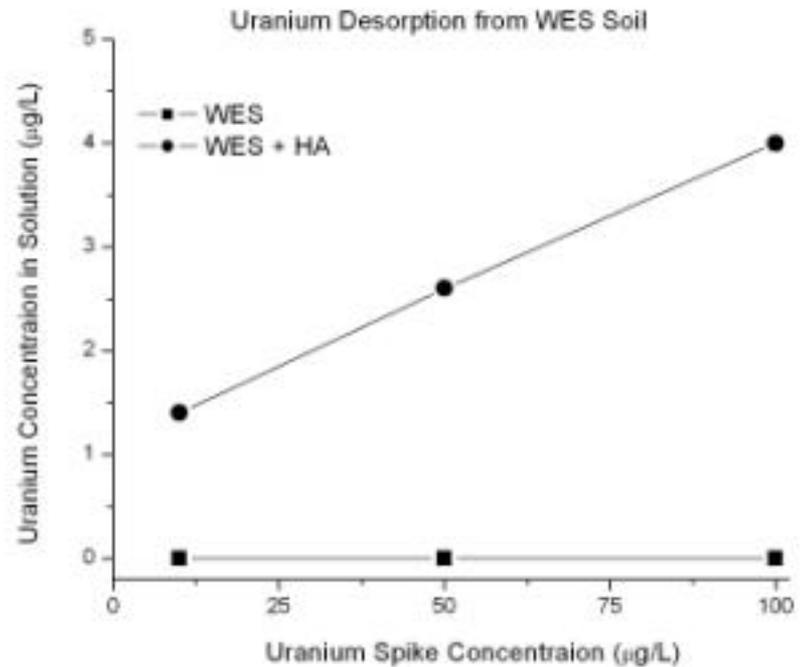
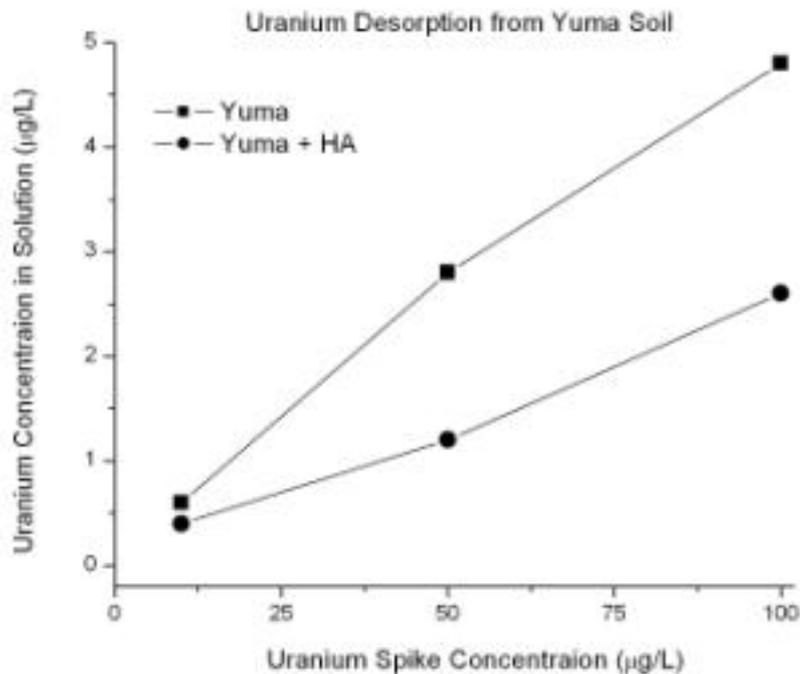


Little effect on sorption of U to some soils, others show more pronounced effects





Effects on desorption of U from soils are pronounced but variable



Conclusions

- Dissolved phase chemistry of radionuclides is greatly affected by the presence of organic compounds (chelating agents)
- Colloidal transport mechanisms affect elements that are not soluble
- Organic matter can greatly impact soil sorption